Higher order methods for the simulation of curvilinear fracture propagation in multi-physics problems

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We develop a novel framework for the higher order simulation of fracturing solids in multi-physics problems. The framework is cast within the context of conforming finite elements, where Universal Meshes [3] provide a conformed discretization for the evolving discontinuity with minimal alterations to the sparsity of data structures. We propose a novel method [2], easily implementable within any finite element framework, that is capable of resolving in an optimally convergent manner the stress singularities arising in fracture mechanics. We further present as part of the proposed framework a suite of robust and rapidly converging numerical tools for the computation of the stress intensity factors for curvilinear fractures [1].

The application of the framework are showcased for complex fracturing problems. In particular, simulations of fracture instabilities in thermoelastic materials subjected to large temperature gradients, where oscillatory fracture behavior is expected, will be used to demonstrate the robustness and capabilities of the presented tools. Additionally, applications to the simulation hydraulic fracturing in poro-elastic materials will be used to further illustrate the versatility of the proposed framework.

References

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[3] R. Rangarajan and A. J. Lew. Universal Meshes: A new paradigm for computing with nonconforming triangulations. *ArXiv e-prints*, January 2012.